## **ACTIVITY ANSWER SHEET:**

**Activity I**

**Questions:**

1. **How well did your seismograph work?**

**Answers: vary**

1. **Name (3) ways you could change or improve on your model?**

**Answers: vary**

1. **Why is it important to know the size, intensity or magnitude of an earthquake?**

**Answer: Impact or effect it will have**

## **Activity IIA: Can You Outrun the Tsunami?**

### Overview

This activity is adapted from the “[NOVA](http://www.pbs.org/wgbh/nova/): Wave That Shook the World” Classroom Activity.

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### Background

Knowing information about wave physics can save lives. You may have seen videos of the terrible destructive power of **tsunamis**. These shallow-water waves happen when large amounts of water are displaced, for example by earthquakes, icebergs falling into the ocean or even a volcanic eruption. When scientists detect these disturbances, they can figure out how fast the tsunami is traveling, where it will hit and when. In this way, they can do their best to evacuate people before the tsunami hits and save lives.

In this activity, **students play the role of scientists working for** NOAA that have received information about a disturbance in the ocean. Unfortunately, the high-tech computing systems have shut down. Students have to use mathematical relationships to determine how long it will take the tsunami to reach given locations.

### Procedure

1. Divide your class into groups of 4-5 students per group. Distribute the Student Activity.
2. Students will have to convert numbers to different units in this exercise. You may want to help students with the conversions by running through an example of m/s to km/h conversation before the activity:

Convert 100m/s to km/hr:

100m/s \* (1m/1,000km) \* (60s/1min) \* (60min/1hr) = 360km/hr

1. Students will read the Tsunami Scenario and identify the given location on a map.
2. Students will use the wave speed formula below to calculate the speed at which the tsunami is traveling. Speed of the tsunami (meters/second) is equal to the square root of g (the acceleration due to gravity, which a constant 9.81 meters/second) times the water depth (d) at which the disturbance occurred (meters).



**NOTE: You may also see reference to tsunami “velocity” (V) at the bowl. Velocity refers to the rate and direction of water displacement but, for our purposes, can be thought of as similar to speed.**

1. Students should convert their final answer to km/h: 1km = 1,000m

1hr = 60 minutes

1. Finally, students fill out the information sheet that will be passed on to emergency services personnel to help warn and aid people in the affected areas.

### Calculating Time to Affected Locations

1. The website listed in this section allows students to enter lat and long information for two locations, and it will calculate the distance between them (km).

<http://www.chemical-ecology.net/java/lat-long.htm>

1. The students can use this site to find the distance between the epicenter and each affected location. (use km)

**ANSWER:**

Seaward to Kodiak latitude = 60.1042 degrees latitude & 149.4422 degrees longitude to 57.7500 degrees latitude to 152.4072 longitude then hit DISTANCE tab = **308.17km** or 193.832 miles

Seaward to Kauai Island, Hawaii 60.1042 degrees latitude & 149.4422 degrees longitude to 57.7500 degrees latitude to 22.0964 degrees latitude & 159.5261degrees longitude then hit Distance tab = **4296.65 km** or 191.48 miles

### Tsunami Scenario

Students are told they have received information that there was an earthquake in Seward, Alaska large enough to produce a tsunami at an ocean depth of 4,000m. Calculate the speed of the tsunami at this depth. Then, calculate the time it will take the tsunami to reach the two following affected locations:

1. Kodiak, Alaska
2. Kauai Island, Hawaii

They should record their data and answer the questions on the information sheet.

### Answer Key

1. Speed of the tsunami:

### S = sqrt(9.81m/s2 \* 4,000m) S = sqrt(39,240m2/s2)

**S = 198m/s**

**(198m/s) \* (1km/1,000m) \* (60s/1min) \* (60min/1hr) = 713km/h**

1. Time that it will take to reach each location: Kodiak, Alaska: **about 26 minutes**

Answer: 308.11 km/713km/hr \*60 min/hr = 25.9 minutes

1. Kauai Island, Hawaii: **about 6 hours**

**Answer:** 4296.65km/713km/hr = 6hr

1. List the locations in the order in which the tsunami will strike in the table below. Indicate some actions at each location that should be taken to help local citizens.

|  |  |  |  |
| --- | --- | --- | --- |
| Order | Affected location  (include coordinates) | Time until  tsunami hits | Emergency actions |
| 1st | **Kodiak, Alaska** | **26 min** | **Emergency actions for each will vary, and may include evacuating coastal residents,**  **alerting local hospitals, sending in emergency supplies from outside the area**  **if there is time, etc.** |
| 2nd | **Kauai Island, Hawaii** | **6 hr** |  |

## Questions: Waves

* 1. Short answer: This term refers to the time it takes identical points on two waves to pass through the same point.

### Answer: Period

* 1. The lowest point on a wave is the:
     1. Crest
     2. Wavelength

### y. Trough

z. Benthic

* 1. Wavelength is best described as the:

w. Vertical distance between a wave’s crest and the next trough

### x. Horizontal distance, either between the crests or troughs of two consecutive waves.

1. The number of waves that pass a given point in a designated amount of time
2. The distance a wave travels in one second
   1. If you followed a single drop of water during a passing wave, it would:
3. Move horizontally
4. Remain stationary
5. Move away from shore

### Move in a circle

* 1. Deep water waves are defined as waves found in water deeper than:

### w. 1/2 their wavelength

1. 1/3 their wavelength
2. 2 times their wavelength
3. 4 times their wavelength
   1. Shallow water waves are defined as waves in water shallower than:

w. 1/2 their wavelength

### x. 1/20 their wavelength

1. 2 times their wavelength
2. 2/3 their wavelength
   1. A wave has a speed of 10m/s and a period of 5s. What is the wavelength of this wave?
3. 2m
4. 5m
5. 10m

### z. 50m (speed= wavelength/period)

* 1. Which of the following is true of a tsunami?

1. A tsunami is a deep water wave
2. A tsunami may be caused by the tides, and thus is sometimes accurately called a tidal wave
3. The speed of a tsunami can be calculated by dividing its depth(d) by the

acceleration due to gravity (g)

z. A tsunami is caused by displacement of large volumes of water, for example Short answer: This term refers to the highest point on a wave.

## **Activity IIB: Tsunami Simulation**

**Discussion questions:**

* Do you think anything could be done to prevent damage to the community? If so, what?

Answers will vary

* How did the tsunami affect the coastal community model? How did it affect the model with rocks? Compare and contrast the effects.

Answers will vary depending on type of model built

* What caused the wave in this experiment? How are waves created in nature?

Part A: Displacement of water mechanically by moving the cardboard

Part B: wind, earthquakes, volcanoes, landslides

* Are all coastal communities at risk? What makes a community more or less at risk?

Answer: All oceanic regions of the world can experience tsunamis, but in the Pacific Ocean and its marginal seas, there is a much more frequent occurrence of large, destructive tsunamis because of the many large earthquakes along the margins of the Pacific Ocean

**B. Plate Tectonics Terminology Worksheet**

Density- Density, mass of a unit volume of a material substance. The formula for density is d = M/V, where d is density, M is mass, and V is volume. Density is commonly expressed in units of grams per cubic centimetre.

Which is more dense the continental plate or the oceanic plate? continental

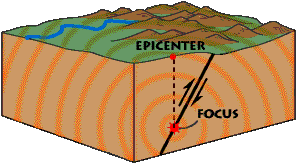
Plate tectonics theory- a theory explaining the structure of the earth's crust and many associated phenomena as resulting from the interaction of rigid lithospheric plates that move slowly over the underlying mantle.

Alfred Wegener- Alfred Wegener proposed the theory of continental drift - the idea that the Earth's continents move over hundreds of millions of years of geologic time

Convection currents- drive plate tectonics. Heat generated from the radioactive decay of elements deep in the interior of the Earth creates magma (molten rock) in the aesthenosphere.

Focus-The location where the earthquake begins.

Epicenter- The point on the Earth's surface located directly above the focus of an earthquake.



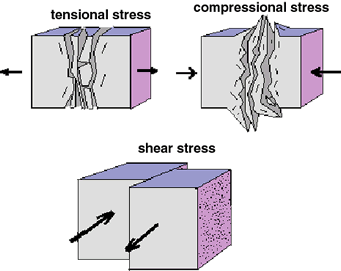
Slip-strike faults & Example- are vertical (or nearly vertical) fractures where the blocks have mostly moved horizontally. (San Andreas fault in CA)

Causes of Earth quakes: (3)

Shearing force- stress is the stress component parallel to a given surface, such as a fault plane, that results from **forces** applied parallel to the surface or from remote **forces** transmitted through the surrounding rock.

Tension-is the stress that tends to pull something apart.

Compression- The stress that squeezes something.



Seismogram- tracing out a record from a seismograph

Seismograph- is an instrument used by scientists to measure the motions of the Earth's surface.

Tsunami- is a shallow-water wave triggered by displacement of a large amount of water

Vent- is an opening exposed on the earth's surface where **volcanic** material is emitted.

Lava- is molten rock generated by geothermal energy and expelled through fractures in planetary crust or in an eruption, usually at temperatures from 700 to 1,200 °C (1,292 to 2,192 °F). ... Explosive eruptions produce a mixture of **volcanic** ash and other fragments called tephra, rather than **lava** flows.

Magma- The molten rock material that originates under the Earth's crust and forms igneous rock when it has cooled.

Mantel- The mantle is the thick layer of hot, solid rock between the Earth's crust and the molten iron core.

Core- The outer core of the Earth is a liquid layer about 2,260 kilometers thick. It is made of iron and nickel.

Crust- Earth's crust is Earth's hard outer layer. It is less than 1% of Earth's volume. The crust is made up of different types of rocks: igneous, metamorphic

Hotspot- is an area in the **mantle** from which heat rises as a thermal plume from deep in the Earth.